AMENDMENTS TO THE CLAIMS

Please amend claims 8-10, 12, and 14 as follows. Please add new claims 21-63.

1. (Withdrawn) A nucleic acid sequence amplification method using polymerase chain reaction (PCR), which method comprises:

a step of injecting into a reaction vessel a sample containing a template DNA having target nucleic acid sequences to be amplified, DNA polymerase, deoxyadenosine triphosphate, deoxycytidine triphosphate, deoxyguanosine triphosphate, deoxythymidine triphosphate, and at least two oligonucleotide primers complementary to the 3' terminus of each of the target nucleic acid sequences; and

a step of maintaining a specific spatial temperature distribution in the sample by contacting thermally with the sample a plurality of heat sources which supply heat to, or remove heat from specific regions of the sample such that a relatively high temperature region is located lower in height than a relatively low temperature region,

wherein the specific spatial temperature distribution comprises specific spatial regions each fulfilling a temperature condition suitable for (i) a denaturation step in which double stranded DNAs become separated to single stranded DNAs, (ii) an annealing step in which the single stranded DNAs formed in the denaturation step hybridize to the primers to form DNA-primer complexes, or (iii) a polymerization step in which the primers in the DNA-primer complexes are extended by the polymerization reaction,

and wherein the specific spatial temperature distribution is a temperature distribution that induces circulation of the sample by thermal convection so that the denaturation, annealing, and polymerization steps occur sequentially and repeatedly inside the sample.

2. (Withdrawn) The nucleic acid sequence amplification method of claim 1, wherein at least one of the heat sources comprises a thermally conductive solid in thermal contact with a specific region of the reaction vessel or the sample; and a heating unit that supplies heat to the thermally conductive solid, a cooling unit that removes heat from the thermally conductive solid, or a combination of the heating unit and the cooling unit.

3. (Withdrawn) The nucleic acid sequence amplification method of claim 1, wherein at least one of the heat sources comprises a liquid in thermal contact with a specific region of the reaction vessel; a receptor in which the liquid is to be contained; and a heating unit that supplies heat to the liquid, a cooling unit that removes heat from the liquid, or a combination of the heating unit and the cooling unit.

4. (Withdrawn) The nucleic acid sequence amplification method of claim 3, wherein at least one of the heat sources further comprises a circulation unit that circulates the liquid around the reaction vessel.

5. (Withdrawn) The nucleic acid sequence amplification method of claim 1, wherein at least one of the heat sources comprises a gas in thermal contact with a specific region of the reaction vessel; a heating unit that supplies heat to the gas, a cooling unit that removes heat from the gas, or a combination of the heating unit and the cooling unit; and a circulation unit that circulates the gas around the reaction vessel.

6. (Withdrawn) The nucleic acid sequence amplification method of claim 1, wherein at least one of the heat sources is an infrared radiation generating unit that supplies heat directly to the sample.

7. (Withdrawn) The nucleic acid sequence amplification method of claim 1, which method uses a means for insulating heat transfer between the heating sources.

8. (Currently amended) A nucleic acid sequence amplification apparatus using PCR, which apparatus comprises:

a plurality of heat sources which may supply heat to, or remove heat from a plurality of specific regions in a sample contained in a reaction vessel wherein the reaction vessel is configured as a straight cylinder or tube,

wherein the heat sources are arranged to maintain a spatial temperature distribution in the sample such that a relatively high temperature region is located lower in height than a

relatively low temperature region in the straight cylinder or tube,

wherein the spatial temperature distribution comprises spatial regions fulfilling temperature conditions suitable for (i) a denaturation step in which double strand DNAs become separated to single strand DNAs, (ii) an annealing step in which the single strand DNAs formed in the denaturation step hybridize to the primers to form DNA-primer complexes, or (iii) a polymerization step in which the primers in the DNA-primer complexes are extended by the polymerization reaction,

and wherein the spatial temperature distribution is a temperature distribution that induces circulation of the sample by thermal convection so that the denaturation, annealing, and polymerization steps occur sequentially and repeatedly inside the sample.

9. (Currently amended) The nucleic acid sequence amplification apparatus of claim 8, wherein at least one of the heat sources comprises a thermally conductive solid in thermal contact with a specific region of the reaction vessel or the sample; and a heating unit that supplies heat to the thermally conductive solid, or a cooling unit that removes heat from the thermally conductive solid, or a combination of the heating unit and the cooling unit.

10. (Currently amended) The nucleic acid sequence amplification apparatus of claim 8, wherein at least one of the heat source comprises a liquid in thermal contact with a specific region of the reaction vessel; a receptor in which the liquid is to be contained; and a heating unit that supplies heat to the liquid, or a cooling unit that removes heat from the liquid, or a combination of the heating unit and the cooling unit.

11. (Original) The nucleic acid sequence amplification apparatus of claim 10, wherein at least one of the heat sources further comprises a circulation unit that circulates the liquid around the reaction vessel.

12. (Currently amended) The nucleic acid sequence amplification apparatus of claim 8, wherein at least one of the heat sources comprises a gas in thermal contact with a specific region of the reaction vessel; a heating unit that supplies heat to the gas, or a cooling unit that removes heat from the gas, or a combination of the heating unit and the cooling unit; and a circulation unit that

circulates the gas around the reaction vessel.

13. (Original) The nucleic acid sequence amplification apparatus of claim 8, wherein at least one of the heat sources is an infrared radiation generating unit that supplies heat directly to the sample.

14. (Currently Amended) The nucleic acid sequence amplification apparatus of claim 8, which apparatus comprises ~~method uses~~ a means for insulating heat transfer between the heat sources.

15. (Withdrawn) The method according to claim 1, wherein the heat source is shaped to comprise at least one protrusion that fits in an opening of the reaction vessel, wherein said protrusion contacts the sample.

16. (Original) The apparatus according to claim 8, wherein the heat source is shaped to comprise at least one protrusion that fits in an opening of the reaction vessel, wherein said protrusion contacts the sample.

17. (Withdrawn) The nucleic acid sequence amplification method of claim 1, wherein the plurality of the heat sources comprises a first thermally conductive solid that is in thermal contact with a lower portion of the reaction vessel and a second thermally conductive solid that is in thermal contact with an upper portion of the reaction vessel.

18. (Withdrawn) The nucleic acid sequence amplification method of claim 17, wherein the plurality of the heat sources further comprises a third thermally conductive solid that is in thermal contact with an intermediate portion of the reaction vessel in between the upper and lower portions.

19. (Previously presented) The nucleic acid sequence amplification apparatus of claim 8, wherein the plurality of the heat sources comprises a first thermally conductive solid that is in thermal contact with a lower portion of the reaction vessel and a second thermally conductive solid that is in thermal contact with an upper portion of the reaction vessel.

20. (Previously presented) The nucleic acid sequence amplification apparatus of claim 19, wherein the plurality of the heat sources further comprises a third thermally conductive solid that is in thermal contact with an intermediate portion of the reaction vessel in between the upper and lower portions.

21. (New) The nucleic acid sequence amplification apparatus of claim 8, wherein the reaction vessel is vertical with respect to the heat sources.

22. (New) The nucleic acid sequence amplification apparatus of claim 8, wherein the thermal convection is bidirectional.

23. (New) The nucleic acid sequence amplification apparatus of claim 14, wherein the insulating means is a solid, liquid or a gas.

24. (New) The nucleic acid sequence amplification apparatus of claim 23, wherein the gas is air.

25. (New) The nucleic acid sequence amplification apparatus of claim 8, wherein the reaction vessel is pressurized.

26. (New) The nucleic acid sequence amplification apparatus of claim 8, wherein the spatial temperature distribution of the reaction vessel further comprises a convection region positioned between the relatively high temperature region and the relatively low temperature region.

27. (New) The nucleic acid sequence amplification apparatus of claim 8, wherein the reaction vessel comprises a top end and a bottom end

28. (New) The nucleic acid sequence amplification apparatus of claim 8, wherein the reaction vessel is tapered.

29. (New) The nucleic acid sequence amplification apparatus of claim 27, wherein the reaction vessel is tapered from the top end to the bottom end.

30. (New) The nucleic acid sequence amplification apparatus of claim 27, wherein the reaction vessel is tapered from the bottom end to the top end.

31. (New) The nucleic acid sequence amplification apparatus of claim 27, wherein the bottom end is closed.

32. (New) The nucleic acid sequence amplification apparatus of claim 8, wherein the apparatus further comprises multiple reaction vessels.

33. (New) A nucleic acid sequence amplification apparatus using PCR, which apparatus comprises:

a plurality of heat sources which may supply heat to, or remove heat from a plurality of specific regions in a sample contained in a reaction vessel comprising a single straight channel,

wherein the heat sources are arranged to maintain a spatial temperature distribution in the sample such that a relatively high temperature region is located lower in height than a relatively low temperature region in the straight channel,

wherein the spatial temperature distribution comprises spatial regions fulfilling temperature conditions suitable for (i) a denaturation step in which double strand DNAs become separated to single strand DNAs, (ii) an annealing step in which the single strand DNAs formed in the denaturation step hybridize to the primers to form DNA-primer complexes, or (iii) a polymerization step in which the primers in the DNA-primer complexes are extended by the polymerization reaction,

and wherein the spatial temperature distribution is a temperature distribution that induces circulation of the sample by thermal convection so that the denaturation, annealing, and polymerization steps occur sequentially and repeatedly inside the sample.

34. (New) The nucleic acid sequence amplification apparatus of claim 33, wherein the reaction vessel is vertical with respect to the heat sources.

35. (New) The nucleic acid sequence amplification apparatus of claim 33, wherein the thermal convection is bidirectional.

36. (New) The nucleic acid sequence amplification apparatus of claim 33, wherein the reaction vessel is cylindrical.

37. (New) The nucleic acid sequence amplification apparatus of claim 33, wherein the reaction vessel comprises a top end and a bottom end.

38. (New) The nucleic acid sequence amplification apparatus of claim 33, wherein the reaction vessel is tapered.

39. (New) The nucleic acid sequence amplification apparatus of claim 37, wherein the reaction vessel is tapered from the top end to the bottom end.

40. (New) The nucleic acid sequence amplification apparatus of claim 37, wherein the reaction vessel is tapered from the bottom end to the top end.

41. (New) The nucleic acid sequence amplification apparatus of claim 37, wherein the bottom end is closed.

42. (New) A nucleic acid sequence amplification apparatus using PCR, which apparatus comprises:

a plurality of heat sources which may supply heat to, or remove heat from a plurality of specific regions in a sample contained in a reaction vessel,

wherein the heat sources are arranged to maintain a spatial temperature distribution in the sample such that relatively high temperature regions are each located lower in height than a relatively low temperature region,

wherein the spatial temperature distribution comprises spatial regions fulfilling temperature conditions suitable for (i) a denaturation step in which double strand

DNAs become separated to single strand DNAs, (ii) an annealing step in which the single strand DNAs formed in the denaturation step hybridize to the primers to form DNA-primer complexes, or (iii) a polymerization step in which the primers in the DNA-primer complexes are extended by the polymerization reaction,

and wherein the spatial temperature distribution is a temperature distribution that induces circulation of the sample by thermal convection so that the denaturation, annealing, and polymerization steps occur sequentially and repeatedly inside the sample.

43. (New) The nucleic acid sequence amplification apparatus of claim 42, wherein the relatively high temperature regions consists of a first and second high temperature region.

44. (New) The nucleic acid sequence amplification apparatus of claim 42, wherein the reaction vessel comprises an open end.

45. (New) The nucleic acid sequence amplification apparatus of claim 42, wherein the thermal convection is bidirectional.

46. (New) The nucleic acid sequence amplification apparatus of claim 42, wherein the spatial temperature distribution of the reaction vessel further comprises a convection region positioned between the relatively high temperature regions and the relatively low temperature region.

47. (New) A nucleic acid sequence amplification apparatus using PCR, which apparatus comprises:

a plurality of heat sources which may supply heat to, or remove heat from a plurality of specific regions in a sample contained in a reaction vessel,

wherein the heat sources are arranged to maintain a spatial temperature distribution in the sample such that a relatively high temperature region is located lower in height than relatively low temperature regions,

wherein the spatial temperature distribution comprises spatial regions fulfilling temperature conditions suitable for (i) a denaturation step in which double strand DNAs become separated to single strand DNAs, (ii) an annealing step in which the

single strand DNAs formed in the denaturation step hybridize to the primers to form DNA-primer complexes, or (iii) a polymerization step in which the primers in the DNA-primer complexes are extended by the polymerization reaction,

and wherein the spatial temperature distribution is a temperature distribution that induces circulation of the sample by thermal convection so that the denaturation, annealing, and polymerization steps occur sequentially and repeatedly inside the sample.

48. (New) The nucleic acid sequence amplification apparatus of claim 47, wherein the relatively low temperature regions consists of a first and second low temperature region.

49. (New) The nucleic acid sequence amplification apparatus of claim 47, wherein the spatial temperature distribution of the reaction vessel further comprises a convection region positioned between the relatively high temperature region and the relatively low temperature regions.

50. (New) The nucleic acid sequence amplification apparatus of claim 47, wherein the reaction vessel comprises an open inlet end and an open outlet end.

51. (New) The nucleic acid sequence amplification of claim 47, wherein the thermal convection is bidirectional.

52. (New) A nucleic acid sequence amplification apparatus using PCR, which apparatus comprises:

a plurality of heat sources which may supply heat to, or remove heat from a plurality of specific regions in a sample contained in a reaction vessel, wherein the reaction vessel comprises one or two open ends,

wherein the heat sources are arranged to maintain a spatial temperature distribution in the sample such that a relatively high temperature region is located lower in height than a relatively low temperature region,

wherein the spatial temperature distribution comprises spatial regions fulfilling temperature conditions suitable for (i) a denaturation step in which double strand DNAs become separated to single strand DNAs, (ii) an annealing step in which the single strand DNAs formed in the denaturation step hybridize to the primers to form DNA-primer complexes, or (iii) a polymerization step in which the primers in the

DNA-primer complexes are extended by the polymerization reaction,

and wherein the spatial temperature distribution is a temperature distribution that induces circulation of the sample by thermal convection so that the denaturation, annealing, and polymerization steps occur sequentially and repeatedly inside the sample.

53. (New) The nucleic acid sequence amplification apparatus of claim 52, wherein the thermal convection is bidirectional.

54. (New) The nucleic acid sequence amplification apparatus of claim 52, wherein the reaction vessel is pressurized.

55. (New) The nucleic acid sequence amplification apparatus of claim 33, 42, 47, or 52, wherein at least one of the heat sources comprises a thermally conductive solid in thermal contact with a specific region of the reaction vessel or the sample; and a heating unit that supplies heat to the thermally conductive solid, or a cooling unit that removes heat from the thermally conductive solid, or a combination of the heating unit and the cooling unit.

56. (New) The nucleic acid sequence amplification apparatus of claim 33, 42, 47, or 52, wherein at least one of the heat source comprises a liquid in thermal contact with a specific region of the reaction vessel; a receptor in which the liquid is to be contained; and a heating unit that supplies heat to the liquid, or a cooling unit that removes heat from the liquid, or a combination of the heating unit and the cooling unit.

57. (New) The nucleic acid sequence amplification apparatus of claim 56, wherein at least one of the heat sources further comprises a circulation unit that circulates the liquid around the reaction vessel.

58. (New) The nucleic acid sequence amplification apparatus of claim 33, 42, 47, or 52, wherein at least one of the heat sources comprises a gas in thermal contact with a specific region of the reaction vessel; a heating unit that supplies heat to the gas, or a cooling unit that removes heat from the gas, or a combination of the heating unit and the cooling unit; and a circulation unit that

circulates the gas around the reaction vessel.

59. (New) The nucleic acid sequence amplification apparatus of claim 33, 42, 47, or 52, wherein at least one of the heat sources is an infrared radiation generating unit that supplies heat directly to the sample.

60. (New) The nucleic acid sequence amplification apparatus of claim 33, 42, 47, or 52, which apparatus comprises a means for insulating heat transfer between the heat sources.

61. (New) The apparatus according to claim 33, 42, 47, or 52, wherein the heat source is shaped to comprise at least one protrusion that fits in an opening of the reaction vessel, wherein said protrusion contacts the sample.

62. (New) The nucleic acid sequence amplification apparatus of claim 33, 42, 47, or 52, wherein the plurality of the heat sources comprises a first thermally conductive solid that is in thermal contact with a lower portion of the reaction vessel and a second thermally conductive solid that is in thermal contact with an upper portion of the reaction vessel.

63. (New) The nucleic acid sequence amplification apparatus of claim 62, wherein the plurality of the heat sources further comprises a third thermally conductive solid that is in thermal contact with an intermediate portion of the reaction vessel in between the upper and lower portions.